Biological Survey of Pacific Hake, Walleye Pollock and Spiny Dogfish in the Strait of Georgia. *R/V G.B. REED*, March 18-29, 1985

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BIOLOGICAL SURVEY OF PACIFIC HAKE, WALLEYE POLLOCK AND SPINY DOGFISH IN THE STRAIT OF GEORGIA. R/V G.B. REED, MARCH 18-29, 1985

by

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ABSTRACT

Shaw, W., D. Davenport, and G. A. McFarlane. 1986. Biological survey of Pacific hake, walleye pollock and spiny dogfish in the Strait of Georgia. R/V G.B. REED, March 18-29, 1985. Can. Data Rep. Fish. Aquat. Sci. 656: 87 p.

A total of 26 midwater trawl tows was completed in the Strait of Georgia from March 18 to 29. Pacific hake accounted for 39.7% of the total catch of all species. Modal lengths of hake were 13, 24 and 41 cm. Age 7+ fish dominated the age composition representing the strong 1978 year-class. Length at 50% maturity was 29.9 cm for males and 33.2 cm for females. Approximately 45% of the males and 9% of the females examined were in spawning condition. Walleye pollock accounted for 33.6% of the total catch of all species. Modal lengths of pollock were 29 and 40 cm. Approximately 70% of the males and 24% of the females examined were in spawning condition. Spiny dogfish accounted for 26.3% of the total catch of all species. Twenty-one percent of the dogfish were juveniles ($\leq$60 cm) and most of these fish were caught at Halibut Bank and off Cape Lazo. Large adult dogfish ($\geq$100 cm) were caught in abundance off Galiano Island, Halibut Bank, and off Cape Lazo. Sixty-five percent of the dogfish examined were immature.

Key words: Pacific hake, walleye pollock, spiny dogfish, biology, Strait of Georgia

RESUME

Shaw, W., D. Davenport, and G. A. McFarlane. 1986. Biological survey of Pacific hake, walleye pollock and spiny dogfish in the Strait of Georgia. R/V G.B. REED, March 18-29, 1985. Can. Data Rep. Fish. Aquat. Sci. 656: 87 p.

Du 18 au 29 mars 1985, on a effectué 26 traits au chalut mésopélagique dans le détroit de Géorgie. Le merlu du Pacifique, dont les longueurs modales se situaient à 13, 24 et 41 cm, représentait 39,7% des prises totales. Les poissons d'âge 7+ de l'importante classe de 1978 dominaient la composition par âge. La longueur où 50% des individus atteignent la maturité se situaient à 29,9 cm chez les mâles et à 33,2 cm chez les femelles. Environ 45% des mâles et 9% des femelles examinés étaient prêts à frayer. La morue du Pacifique occidental, dont les longueurs modales se situaient à 29 et 40 cm, représentait 33,6% des prises totales. Environ 70% des mâles et 24% des femelles examinés étaient en état de frayer. L'aiguillat commun constituait 26,3% des prises totales; 21% étaient des aiguillats étaient es juvéniles ($\leq$60 cm) en majorité capturés sur le banc Halibut et au large du cap Lazo. De gros aiguillats adultes ($\geq$100 cm) ont été pris en grand nombre au large de l'île Galiano et du cap Lazo et sur le banc Halibut. Parmi les aiguillats examinés, 65% étaient immatures.

Mots-clés: merlu du Pacifique, morue du Pacifique occidental, aiguillat commun, biologie, détroit de Géorgie

INTRODUCTION

During March 1985, the Groundfish program of the Pacific Biological Station conducted their annual biological survey of Pacific hake (Merluccius productus) and walleye pollock (Theragra chalcogramma) stocks in the Strait of Georgia. This is an on-going study to monitor the spawning concentrations of Pacific hake and walleye pollock. In addition biological data were collected from spiny dogfish (Squalus acanthias).

This report presents the set location data and summarizes the results of the catch composition and the biological sampling.

METHODS AND MATERIALS

The R/V G.B. REED was used during the survey. The fishing and echosounding equipment and procedures, catch estimations, and sub-sampling methods used during this survey were the same as those used during the 1983 and 1984 surveys by Shaw et al. (1985) and (1986) respectively. The tracklines followed during the echosounding survey were the same as outlined for the 1984 survey (Shaw et al. 1985).

Hake and pollock were sampled for sex and maturity states (Weir et al. 1978); measured for fork length; and weighed to the nearest gram using a Digimetric 30 DTI top-load electronic balance equipped with a digital integrator. Paired otoliths from hake and the left pectoral fin from pollock were collected for age determination as outlined in Beamish (1979) and (1981) respectively. Dogfish were sampled for sex and maturity states (Beamish and Smith 1976); and measured for total length (the tip of the upper lobe of the caudal fin when depressed in a line horizontal to the body). The stomach contents from hake, pollock and dogfish were identified if possible and a visual estimate of the volume (cc) was made.

Incidental catches of brown cat shark (Apristurus brunneus) were examined for sex and measured for total length.

Water temperature profiles were collected at selected stations using expendable bathythermographs (XBT). Seven of the stations were the same as in the 1984 survey (Shaw et al. 1986).

RESULTS AND DISCUSSION

CRUISE SUMMARY

During March 18-29, a total of 26 midwater tows was completed in the Strait of Georgia from Mitlenatch Island to Galiano Island (Fig. 1). One set (No. 10) was completed inside Jervis Inlet. The bridge log information and species composition of catches by haul are listed in Appendix table 1.

The location of the tracklines travelled during the echogram survey is outlined in Figure 2. Results of the survey indicated the presence of 2 distinct midwater layers. The concentration of each layer was determined subjectively, in the same manner as in the past surveys by Shaw et al. (1985) and (1986), using the procedure described in Thompson and McFarlane (1982). The first midwater layer or the shallow spotting layer ranged in depth from 55-165 m. The density estimates ranged from nil, north of Texada Island and south of Porlier Pass, to heavy spotting south of Texada Island (Fig. 3). The light spotting layer dominated the first midwater layer, as it did in the 1984 survey (Shaw et al. 1986).

The second midwater layer or the main concentration ranged in depth from 140-402 m. The density estimates ranged from nil, in very small localized areas in the central Strait of Georgia, to very heavy off Cape Lazo, Nanaimo, Halibut Bank, and Porlier Pass (Fig. 4). The density estimate dominating the second midwater layer was medium, as in the 1984 survey (Shaw et al. 1986). The difference between the 1984 echogram results and this survey was the presence of a very heavy layer located off of Nanaimo and off Porlier Pass. This survey did not find the large very heavy layer off Sandheads as reported in the 1984 survey. The very heavy layer found off Cape Lazo ranged in depth from 165-274 m; 155-229 m off Nanaimo; 155-366 m off Halibut Bank; and 183-238 m off Porlier Pass. It is of interest that for some areas in the Strait of Georgia the second midwater layer was composed of 2 distinct layers which generally ranged from 165-238 m for the top layer and 240-293 m for the bottom layer.

In all, 11 species of fish were captured during the survey. A list of the common and scientific names of the species caught is given in Table 1. The total catch by species during the survey was:

Species	Weight (kg)	% Total catch
Pacific hake	4,181	39.7
Walleye pollock	3,533	33.6
Spiny dogfish	2,767	26.3
Other species[a]	42	0.4
Total	10,523	100.0

[a]Individual totals for other species were $\leq$1% of the total catch.

Water temperature profiles were recorded at 10 stations (Fig. 1). A summary of the temperature profiles by depth interval is given in Table 2. The mean surface temperature in the Strait of Georgia during the survey was 8.6°C. The midwater temperatures deeper than 91 m were approximately 0.5°C cooler than reported in 1984 (Shaw et al. 1986) during the same period.

BIOLOGICAL SAMPLING

Pacific hake

Pacific hake were present in 85% of the sets. Biological samples were taken from 19 (73%) sets. A total of 4050 hake was measured for length and examined for sex; otoliths were removed from 1190 of these fish to determine age composition. A summary of the biological sampling is given in Table 3.

Male hake comprised 65% of the total hake catch and dominated in 79% of the sets. The size composition of hake ranged from 9-81 cm (Appendix table 2). Male hake ranged from 9-52 cm with modal lengths at 11, 23, and 41 cm; and females ranged from 9-81 cm with modal lengths at 13, 24, and 43 cm (Fig. 5). The majority (81%) were adults ranging from 36-47 cm with less than 1% being larger than 50 cm. Age 1+ fish (mode at 13 cm) accounted for 1.5% of the total catch by numbers and were present in 47% of the sets. A large catch of age 1+ fish came from Halibut Bank (set 12) at a depth of 165 m. Age 2+ fish (mode at 24 cm) accounted for 8% of the total catch and were present in 84% of the sets. Relatively large catches of age 2+ fish came from Halibut Bank (set 12) at a depth of 165 m, and south of Texada Island (sets 15 and 16) at depths of 174 m and 229 m respectively.

Pacific hake (sets 11 and 16) ranged from 1 to 15 years (Table 4). The dominant age groups were 3 and 7 yr (1982 and 1978 year-class) (Fig. 6). Seven-year-old fish (strong 1978 year-class) accounted for 24% of the hake caught. The presence of a lot of 3-yr-old fish (1982 year-class) is interesting since they have not been relatively abundant in past surveys during the same period. They accounted for 11% of the hake caught.

A total of 1434 males and 807 females was examined for maturity state (Table 5). Most of the males (45.2%) were spawning (RR) with 4.2% already spent (S). Approximately 28% were in a ripe (R) condition. Most of the females (27.8%) were in a pre-spawning state (1R and 2R) with only 9.3% spawning. Approximately 26% were in a ripe condition. More females (13.0%) than males were examined in a spent condition. The length at 50% maturity, from probit analysis (Leslie et al. 1945), was 29.9 cm for males and 33.2 cm for females.

Individual round weights were recorded from 300 hake of which 221 were in a pre-spawning state. The length-weight relationships are:

Males	Wt (gm) = 0.5509 (FL (cm))$^{1.7449}$	n = 96
Females	Wt (gm) = 0.0017 (FL (cm))$^{3.3549}$	n = 125
Sexes combined	Wt (gm) = 0.0025 (FL (cm))$^{3.2567}$	n = 221

These results are similar to those reported by McFarlane et al. (1983) and Shaw et al. (1986).

A total of 307 hake was examined at sea for stomach contents (Table 6). Approximately 74% of the stomachs were either empty or everted. The principal prey (% volume) was euphausiid (79%). The average volume of food per stomach (excluding empty or everted stomachs) was 2.3 cc.

Walleye pollock

Walleye pollock were present in 69% of the sets. Biological samples were taken from 9 (35%) sets. A total of 1203 pollock was measured for length and examined for sex; pectoral fins were removed from 324 of these fish to determine age composition. Individual round weights were recorded for 138 pollock. A summary of the biological sampling is presented in Table 7.

Male pollock composed 66% of the total pollock catch and dominated in 67% of the sets. Male pollock ranged in length from 21-49 cm with modal lengths at 29 and 40 cm; females ranged from 20-56 cm with modal lengths at 29 and 44 cm (Appendix table 3; Fig. 7). The majority of the fish (68%) were adults ranging in length from 37-43 cm with 2.3% being larger than 50 cm.

The maturity states of pollock were examined from a total of 374 males and 230 females (Table 8). Most of the males (69.5%) were spawning with 6.1% already in a spent condition. Approximately 18% were in a ripe (R) condition. Of the females examined, 23.5% were spawning with most (43.5%) of them in a pre-spawning state (R1-R2) and 15.7% being ripe. About the same percentage of females (7.4%) to males were examined in a spent condition.

Stomach contents were examined from 80 pollock; 98% of the stomachs were either empty or everted (Table 9). The principal prey (% volume) in the remaining fish was northern smoothtongue (Leuroglossus stilbius schmidti) (67%).

Spiny dogfish

Spiny dogfish were present in 92% of the sets. Biological samples were collected from 22 (85%) sets. A total of 761 dogfish was measured for total length and examined for sex. A summary of the biological samples collected is in Table 10.

Male dogfish composed only 19% of the total dogfish catch and dominated in 5% of the sets. Dogfish ranged in length from 11-121 cm (Appendix table 4). Approximately 21% of the dogfish were juveniles ($\leq$60 cm) (Fig. 8). Most of these young fish were caught off Halibut Bank (set 12) at

229 m and south of Texada Island (sets 15 and 16) at 174 m and 229 m, respectively. Large adult female dogfish (≥100 cm) were caught off Galiano Island (set 4) at 200 m; off Halibut Bank (set 7) at 180 m; and off Cape Lazo (set 20) at 179 m.

A total of 517 dogfish were examined for maturity state (Table 11) of which 50% were immature. Approximately 39% of the males examined were mature. Thirty-seven percent of the females were mature with 28% of them containing uterine eggs and 3% containing yolk sac pups.

The stomachs of 433 dogfish were examined for stomach contents; 44% of the stomachs were empty (Table 12). The principal prey (% volume) for juvenile dogfish (≤60 cm) was euphausiid (63%); and for adult dogfish (>60 cm) hake (69%). One Pacific herring was identified in the stomach of an adult (109 cm) dogfish from set 7 and accounted for 0.2% of the stomach contents by volume.

The average volume of food per juvenile (≤60 cm) dogfish stomach (excluding empty stomachs) was 1.8 cc; and 142.6 cc for adult (>60 cm) dogfish stomachs.

Other species sampled

Brown cat shark were present in 31% of the sets and biological samples were collected from 7 (27%) sets. A total of 62 brown cat shark was measured for total length and examined for sex. A summary of the biological samples collected is given in Table 13. Males composed 73% of the total catch of brown cat shark and dominated in 43% of the sets. Males ranged in length from 46-55 cm with a modal length at 53 cm; females ranged from 44-52 cm with a modal length at 49 cm (Appendix table 5).

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Table 1. Common and scientific names of fish species captured during the March 1985 survey.

Common name	Scientific name
Pacific hake	*Merluccius productus*
Walleye pollock	*Theragra chalcogramma*
Chinook salmon	*Oncorhynchus tshawytscha*
Eulachon	*Thaleichthys pacificus*
Pacific cod	*Gadus macrocephalus*
Sablefish	*Anoplopoma fimbria*
Spiny dogfish	*Squalus acanthias*
Brown cat shark	*Apristurus brunneus*
Dover sole	*Microstomus pacificus*
Widow rockfish	*Sebastes entomelas*
Yellowtail rockfish	*Sebastes flavidus*

Table 2. Water temperature (°C) by station and by depth using the XBT. R/V G.B. REED, March 18-29, 1985.

Station no.	Date	Location	Surface (°C)	Midwater (°C)				Bottom depth (m)	Bottom (°C)
				91 m	164 m	201 m	256 m		
A	03/19	48°56.4' 123°20.3'	9.1	8.4	8.2			178	8.1
B	03/19	49°00.0' 123°25.3'	9.0	8.1	8.0	8.3	8.4	288	8.5
C	03/20	49°13.0' 123°28.3'	8.3	8.3	8.2	8.2	8.4	298	8.4
D	03/22	49°44.1' 124°23.2'	9.0	8.3	8.6	8.9	9.2	335	9.3
E	03/22	49°56.9' 125°05.2'	9.0	8.8	8.4	8.4	8.4	285	8.4
F	03/22	49°45.4' 124°46.0'	8.6	8.5	8.2	8.3	8.4	331	8.6
G	03/22	49°35.6' 124°27.0'	8.5	8.5	8.4	8.5	8.6	313	8.7
H	03/25	49°18.3' 123°48.4'	8.0	7.8	7.9	7.9	8.6	392	8.1
I	03/25	49°25.7' 124°04.7'	8.4	8.1	8.0	8.6	8.9	359	8.2
J	03/25	49°25.6' 124°22.0'	8.5	8.4	8.6	8.9	9.3	355	9.3
Temperature Range (°C)			8.0-9.1	7.8-8.8	7.9-8.6	7.9-8.9	8.4-9.3		8.1-9.3
$\bar{x}$ temperature (°C)			8.6	8.3	8.3	8.4	8.7		8.6

Table 3. Biological samples of Pacific hake by set. R/V G.B. REED, March 18-29, 1985.

Set no.	Average net depth (m)	Length			Maturity	Stomach contents	Body weights	Paired otoliths	Remarks
		M	F	T					
2	201	238	76	314	240	-	-	240	Random 6 tubs
4	199	252	37	289	95	14	-	-	Random
6	256	102	163	265	93	-	-	-	T.C.[a]
7	180	11	0	11	11	11	-	-	T.C.
8	229	185	77	262	178	-	100	178	Random
10	174	68	62	130	130	130	130	-	T.C.
11	247	129	197	326	179	20	-	179	Random
12	165	131	35	166	166	-	-	-	Random
13	201	204	140	344	93	-	-	-	Random
14	274	25	66	91	91	-	13	1	Random
15	174	299	108	410	159	47	48	-	Random
16	229	130	202	332	211	-	-	211	Random
17	215	252	38	290	189	27	-	189	Random
20	179	42	3	45	45	18	-	-	T.C.
21	252	149	129	278	192	20	9	192	Random
22	187	230	53	283	100	20	-	-	Random
23	224	46	23	69	69	-	-	-	Random
25	201	74	6	80	-				
26	210	55	10	65	-				
Total		2622	1425	4050	2241	307	300	1190	

[a]T.C.=Total catch sampled.

Table 4. Mean size at age of Pacific hake for each age class from Sets 11 and 16. R/V G.B. REED, March 18-29, 1985.

	Male			Female			Total		
Age	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.	N
1	-	-	-	12.5	0.50	3	12.5	0.50	3
2	24.2	1.90	16	24.4	1.79	10	24.3	1.82	26
3	36.0	1.97	19	37.0	2.08	22	36.5	2.07	41
4	37.9	1.92	13	39.4	2.14	24	38.9	2.17	37
5	40.6	1.49	12	40.6	1.30	17	40.6	1.35	29
6	39.8	1.23	10	42.3	2.53	19	41.4	2.46	29
7	41.1	1.71	34	42.0	2.02	58	41.7	1.94	92
8	41.7	1.33	17	43.2	1.98	31	42.7	1.91	48
9	42.5	1.43	10	44.8	2.60	14	43.8	2.43	24
10	43.7	1.50	7	46.2	3.10	13	45.3	2.88	20
11	43.8	2.08	7	45.3	2.15	8	44.6	2.18	15
12	44.8	3.82	2	48.3	4.40	6	47.5	4.31	8
13	42.6	1.70	2	46.5	1.19	3	44.9	2.43	5
14	-	-	-	0		0	0		0
15	-	-	-	51.3	5.84	3	51.3	5.84	3
Total			149			231			380

Table 5. Pacific hake maturity frequency by set. R/V G.B. REED, March 18-29,1985.

Set no.	2			4			6			7		
Gonad maturity stage	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	1	-	1	-	-	-	-	-	-
I2	-	-	-	0	-	0	7	8	15	-	-	-
R1	-	-	-	1	-	1	0	0	0	-	-	-
R2	16	4	20	10	1	11	1	8	9	1	-	1
R	84	19	103	17	1	18	4	22	26	3	-	3
1R	0	0	0	0	0	0	0	2	2	0	-	0
2R	0	20	20	0	4	4	0	10	10	0	-	0
RR	66	12	78	52	8	60	18	2	20	7	-	7
S	9	8	17	-	-	-	5	6	11	-	-	-
Rb	0	-	0	-	-	-	-	-	-	-	-	-
Rc	0	-	0	-	-	-	-	-	-	-	-	-
Rt	2	-	2	-	-	-	-	-	-	-	-	-
Total	177	63	240	81	14	95	35	58	93	11	0	11

Table 5 (cont'd)

Set no.	8			10			11			12		
Gonad maturity stage	M	F	T	M	F	T	M	F	T	M	F	T
I1	2	-	2	4	5	9	-	2	2	24	10	34
I2	0	-	0	29	24	53	-	0	0	31	21	52
R1	0	-	0	3	4	7	1	0	1	3	0	3
R2	5	2	7	5	4	9	3	13	16	12	0	12
R	41	9	50	12	14	26	23	45	68	31	2	33
1R	0	3	3	0	1	1	0	2	2	0	1	1
2R	0	19	19	0	11	11	0	20	20	0	0	0
RR	87	4	91	13	-	13	38	11	49	28	1	29
S	-	6	6	1	-	1	4	16	20	2	-	2
Rb	-	-	-	-	-	-	-	0	0	-	-	-
Rc	-	-	-	-	-	-	-	0	0	-	-	-
Rt	-	-	-	-	-	-	-	1	1	-	-	-
Total	135	43	178	67	63	130	69	110	179	131	35	166

Table 5 (cont'd)

Set no.	13			14			15			16		
Gonad maturity stage	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	-	-	-	36	19	55	-	2	2
I2	-	2	2	4	-	4	9	4	13	17	10	27
R1	-	0	0	1	1	2	21	0	21	1	5	6
R2	10	1	11	3	14	17	10	2	12	14	12	26
R	18	7	25	1	24	25	18	4	22	17	33	50
1R	0	1	1	0	3	3	0	0	0	0	1	1
2R	0	16	16	0	14	14	0	3	3	0	36	36
RR	23	4	27	13	3	16	31	0	31	33	7	40
S	4	7	11	-	10	10	-	2	2	3	20	23
Rb	-	-	-	-	-	-	-	-	-	-	-	-
Rc	-	-	-	-	-	-	-	-	-	-	-	-
Rt	-	-	-	-	-	-	-	-	-	-	-	-
Total	55	38	93	22	69	91	125	34	159	85	126	211

Table 5 (cont'd)

Set no.	17			20			21			22		
Gonad maturity stage	M	F	T	M	F	T	M	F	T	M	F	T
I1	2	2	4	-	2	2	-	-	-	2	-	2
I2	0	1	1	-	1	1	1	-	1	0	-	0
R1	0	0	0	2	-	2	0	1	1	3	-	3
R2	6	0	6	1	-	1	8	4	12	4	1	5
R	57	2	59	12	-	12	17	19	36	32	6	38
1R	0	0	0	0	-	0	0	3	3	0	1	1
2R	0	12	12	0	-	0	0	21	21	0	6	6
RR	88	3	91	27	-	27	57	19	76	44	1	45
S	14	2	16	-	-	-	18	24	42	-	-	-
Rb	-	-	-	-	-	-	-	-	-	-	-	-
Rc	-	-	-	-	-	-	-	-	-	-	-	-
Rt	-	-	-	-	-	-	-	-	-	-	-	-
Total	167	22	189	42	3	45	101	91	192	85	15	100

Table 5 (cont'd)

Set no.	23			Total		
Gonad maturity stage	M	F	T	M	F	T
I1	-	-	-	71	42	113
I2	-	1	1	98	72	170
R1	-	0	0	36	11	47
R2	3	1	4	112	67	179
R	20	4	24	407	211	618
1R	0	0	0	0	18	18
2R	0	13	13	0	205	205
RR	23	0	23	648	75	723
S	-	4	4	60	105	165
Rb	-	-	-	0	0	0
Rc	-	-	-	0	0	0
Rt	-	-	-	2	1	3
Total	46	23	69	1434	807	2241

Table 6. Pacific hake stomach contents. R/V G.B. REED, March 18-29, 1985.

Number examined	307	
Number empty	154	
Number everted	73	
Food items	**Volume (cc)**	**%**
Northern smoothtongue	20	11.8
Fish remains (unid)	6	3.6
Euphausiid	133	78.7
Shrimp	10	5.9
Total	169	100.0

Table 7. Biological samples of walleye pollock by set. R/V G.B. REED, March 18-29, 1985.

Set. no.	Length			Maturity	Stomach contents	Body weight	Pectoral fin	Sampling remarks
	M	F	T					
4	173	138	311	232	17	-	162	Random
6	57	66	123	-	-	-	-	Random
7	170	2	172	90	20	55	90	Random
8	46	63	109	72	20	65	72	Random
11	57	72	129	81	20	-	-	Random
12	86	5	91	-	-	-	-	Random
13	178	48	226	87	-	-	-	Random
14	22	17	39	39	-	18	-	T.C.
22	2	1	3	3	3	-	-	T.C.[a]
Total	791	412	1203	604	80	138	324	

[a]T.C.=Total catch sampled.

Table 8. Walleye pollock maturity frequency by set. R/V G.B.REED, March 18-29,1985.

Set no.	4			7			8			11		
Gonad maturity stage	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	-	-	-	1	2	3	-	-	-
I2	-	-	-	1	-	1	0	1	1	-	1	1
R1	1	-	1	0	-	0	0	0	0	-	0	0
R2	16	2	18	0	-	0	0	1	1	2	0	2
R	42	16	58	1	-	1	1	0	1	13	16	29
1R	0	7	7	0	-	0	0	2	2	0	3	3
2R	0	48	48	0	-	0	0	11	11	0	16	16
RR	51	19	70	86	2	88	26	22	48	24	3	27
S	18	5	23	-	-	-	-	3	3	-	3	3
Rb	0	0	0	-	-	-	-	0	0	-	-	-
Rc	0	0	0	-	-	-	-	1	1	-	-	-
Rt	1	6	7	-	-	-	-	1	1	-	-	-
Total	129	103	232	88	2	90	28	44	72	39	42	81

Table 8 (cont'd)

Set no.	13			14			22			Total		
Gonad maturity stage	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	-	-	-	-	-	-	1	2	3
I2	-	-	-	-	-	-	-	-	-	1	2	3
R1	-	-	-	-	-	-	-	-	-	1	0	1
R2	-	-	-	-	-	-	-	-	-	18	3	21
R	11	3	14	1	1	2	-	-	-	69	36	105
1R	0	0	0	0	2	2	-	-	-	0	14	14
2R	0	7	7	0	12	12	-	-	-	0	94	94
RR	56	2	58	15	5	20	2	-	2	260	53	313
S	3	5	8	2	1	3	-	-	0	23	17	40
Rb	-	-	-	-	-	-	-	-	0	0	0	0
Rc	-	-	-	-	-	-	-	1	1	0	2	2
Rt	-	-	-	-	-	-	-	-	-	1	7	8
Total	70	17	87	18	21	39	2	1	3	374	230	604

Table 9. Walleye pollock stomach contents. R/V G.B. REED, March 18-29, 1985.

Number examined	80	
Number empty	76	
Number everted	2	
Food items	**Volume (cc)**	**%**
Northern smoothtongue	2	66.7
Euphausiid	1	33.3
Total	3	100.0

Table 10. Biological samples of spiny dogfish by set. R/V G.B. REED, March 18-29, 1985.

Set. no.	Length			Maturity	Stomach contents	Sampling remarks
	M	F	T			
2	1	10	11	-	-	T.C.[a]
4	2	110	112	30	-	Random
6	2	22	24	-	-	Random
7	1	116	117	46	46	Random
8	1	16	17	17	17	T.C.
10	3	14	17	17	17	T.C.
11	7	19	26	26	26	T.C.
12	11	15	26	26	-	T.C.
13	2	11	13	13	13	T.C.
14	6	15	21	21	21	T.C.
15	14	44	58	58	58	T.C.
16	40	44	84	84	83	T.C.
17	11	16	27	17	27	T.C.
18	2	6	8	8	8	T.C.
19	0	15	15	15	15	T.C.
20	8	61	69	69	33	T.C.
21	21	13	34	34	34	T.C.
22	5	18	23	23	23	T.C.
23	3	10	13	13	12	T.C.
24	0	3	3	-	-	T.C.
25	2	23	25	-	-	T.C.
26	0	18	18	-	-	T.C.
Total	142	619	761	517	433	

[a]T.C.=Total catch sampled.

Table 11. Spiny dogfish maturity frequency by set. R/V G.B. REED, March 18-29, 1985.

Gonad maturity stage	Set number											
	4		7		8		10		11		12	
	M	F	M	F	M	F	M	F	M	F	M	F
I_1	-		-		1		3		3		10	
I_2	-		-		-		-		1		1	
R	-		-		-		-		3		-	
I_1D_1		-		2		4		5		1		10
I_1D_2		-		7		2		7		1		0
I_1D_3		-		0		0		0		3		0
I_1D_4		-		0		1		0		0		0
R_1D_2		-		3		1		0		2		0
R_1D_3		-		1		0		0		3		0
R_1D_4		-		1		1		0		0		0
R_1D_5		3		7		1		1		5		2
R_2D_3		0		0		1		0		0		1
R_2D_4		0		0		0		0		0		0
R_2D_5		7		10		0		0		0		0
R_2D_6		4		0		0		0		0		0
R_3D_4		0		2		2		0		0		0
R_3D_5		2		1		0		0		0		1
R_3D_6		14		10		3		1		4		1
R_3D_7		-		1		-		-		-		-
R_3D_8		-		1		-		-		-		-
Total	0	30	0	46	1	16	3	14	7	19	11	15

Table 11 (cont'd)

Gonad maturity stage	Set number											
	13		14		15		16		17		18	
	M	F	M	F	M	F	M	F	M	F	M	F
I_1	2		-		13		29		5		-	
I_2	-		-		1		2		0		-	
R	-		6		-		9		3		2	
I_1D_1		2		1		23		35		1		-
I_1D_2		1		2		8		4		2		-
I_1D_3		1		3		0		0		0		-
I_1D_4		0		0		0		0		0		-
R_1D_2		1		0		2		2		0		-
R_1D_3		0		5		3		0		1		-
R_1D_4		0		1		0		0		0		-
R_1D_5		3		0		1		0		3		-
R_2D_3		0		1		0		2		0		-
R_2D_4		0		0		0		1		0		-
R_2D_5		0		1		1		-		0		4
R_2D_6		0		0		0		-		0		0
R_3D_4		0		0		1		-		0		0
R_3D_5		1		0		0		-		0		0
R_3D_6		2		1		5		-		2		2
R_3D_7		-		-		-		-		-		-
R_3D_8		-		-		-		-		-		-
Total	2	11	4	15	14	44	40	44	8	9	2	6

Table 11 (cont'd)

Gonad maturity stage	Set number 19 M	19 F	20 M	20 F	21 M	21 F	22 M	22 F	23 M	23 F	Total M	Total F
I_1	-		3		2		4		-		75	
I_2	-		0		0		0		-		5	
R	-		5		19		1		3		51	
I_1D_1		-		2		1		2		-		89
I_1D_2		-		2		0		2		2		40
I_1D_3		-		0		0		0		0		7
I_1D_4		-		0		0		0		0		1
R_1D_2		-		0		2		1		1		15
R_1D_3		1		0		1		4		0		19
R_1D_4		0		0		0		0		0		3
R_1D_5		7		28		5		7		3		76
R_2D_3		0		0		0		0		0		5
R_2D_4		0		0		0		0		0		1
R_2D_5		0		8		0		0		1		32
R_2D_6		0		0		1		0		0		5
R_3D_4		0		0		1		0		0		6
R_3D_5		2		5		1		1		0		14
R_3D_6		5		16		1		1		3		7
R_3D_7		-		-		-		-		-		1
R_3D_8		-		-		-		-		-		1
Total	0	15	8	61	21	13	5	18	3	10	131	386

Table 12. Spiny dogfish stomach contents. R/V G.B. REED, March 18-29, 1985.

	Dogfish ≤ 60 cm (total length)	Dogfish > 60 cm (total length)	Total
Number examined	118	315	433
Number empty	50	142	192
Food items	Volume (cc)	Volume (cc)	Volume (cc)
Hake	15	16932	16947
Fish remains (unid)	10	3770	3780
Pollock	-	3394	3394
Ratfish	-	75	75
Northern smoothtongue	-	60	60
Herring	-	40	40
Octopus	-	383	383
Euphausiid	79	12	91
Shrimp	22	-	22
Squid	-	20	20
Total	126	24686	24811

Table 13. Biological samples of brown cat shark by set. R/V G.B. REED, March 18-29, 1985.

Set	Length			Sampling
no.	M	F	T	remarks
10	41	7	48	T.C.[a]
13	1	1	2	T.C.
16	1	3	4	T.C.
22	1	0	1	T.C.
23	1	0	1	T.C.
25	0	4	4	T.C.
26	0	2	2	T.C.
Total	45	17	62	

[a]T.C.=Total catch.

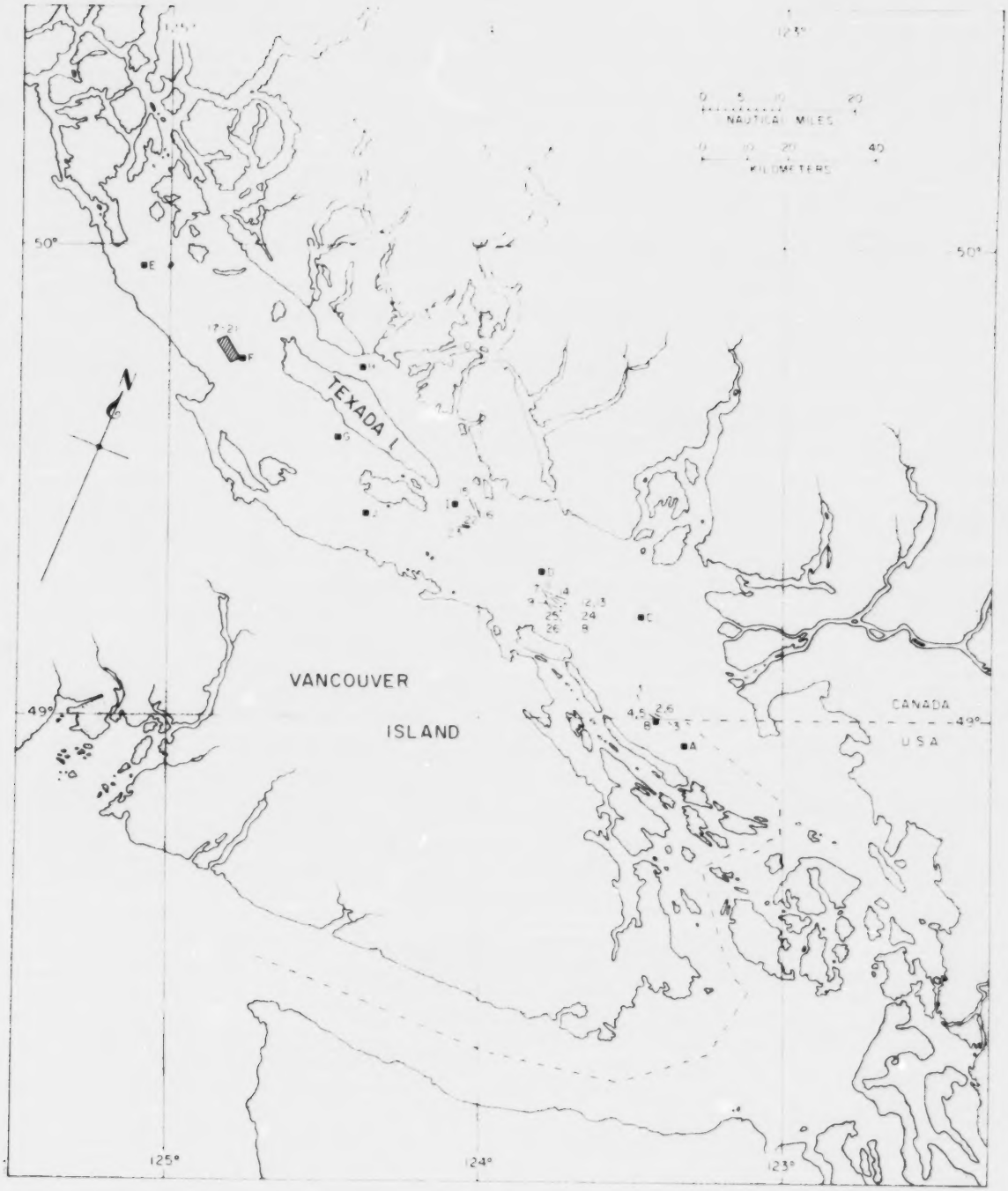

Fig. 1. Set locations in the Strait of Georgia. R/V G.B. REED, March 18-29, 1985. (XBT stations denoted by black square.)

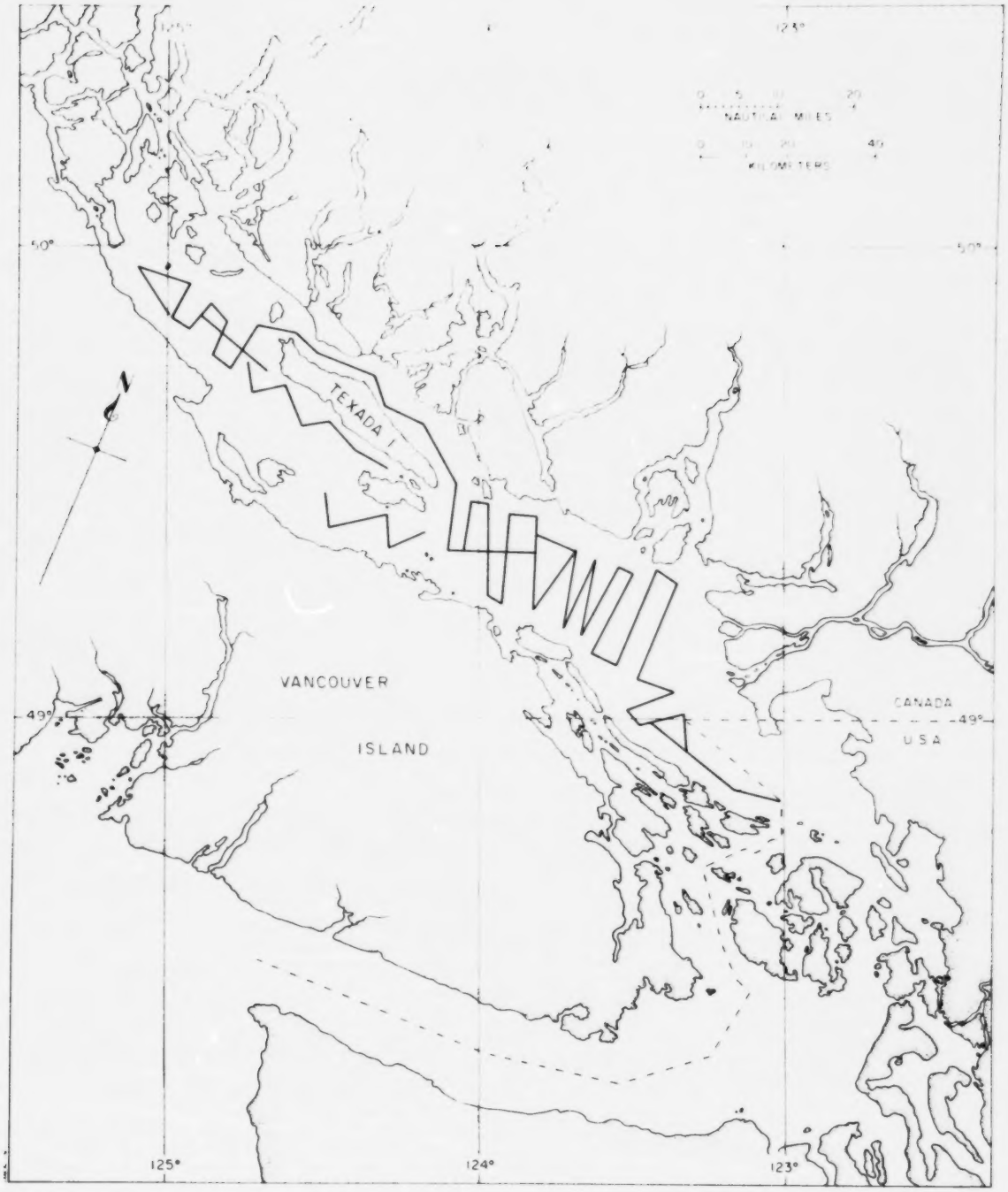

Fig. 2. Echo-sounding survey trackline travelled by the R/V G.B. REED in the Strait of Georgia, March 18-29, 1985.

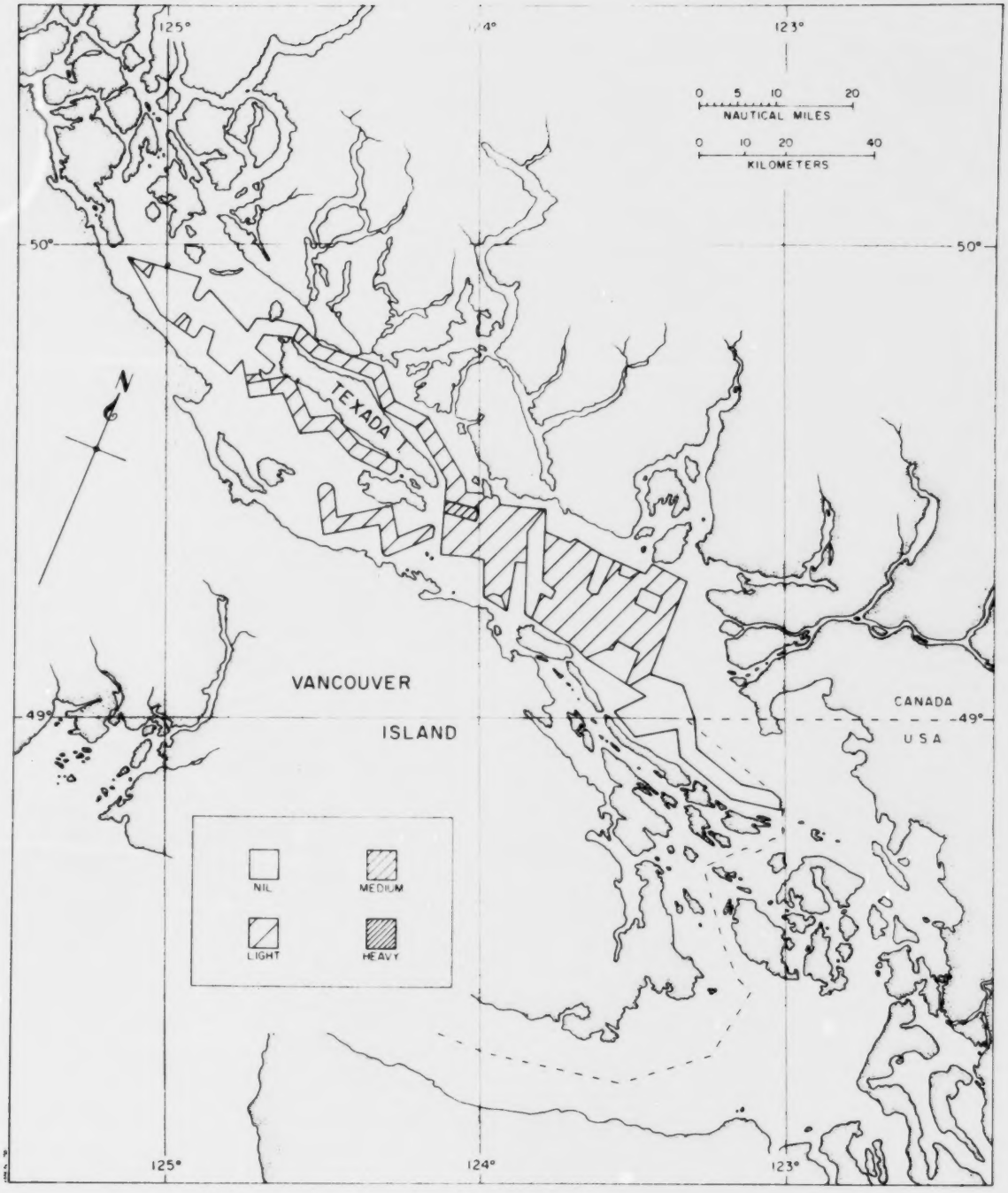

Fig. 3. Fish distribution in the shallow spotting layer in the Strait of Georgia as represented by echogram estimates of volume density. R/V G.B. REED, March 18-29, 1985.

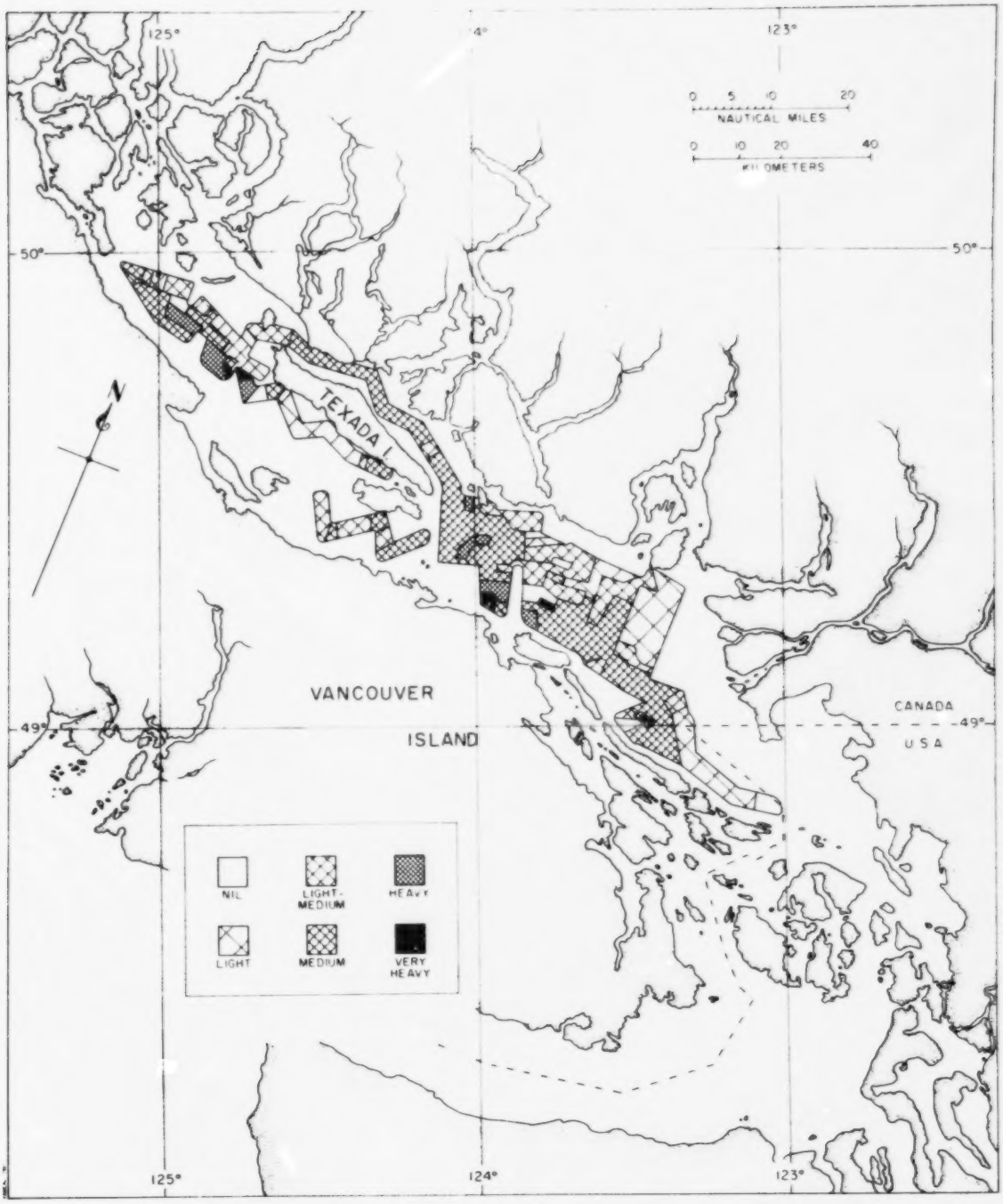

Fig. 4. Fish distribution in the main concentration layer in the Strait of Georgia as represented by echogram estimates of volume density. R/V G.B. REED, March 18-29, 1985.

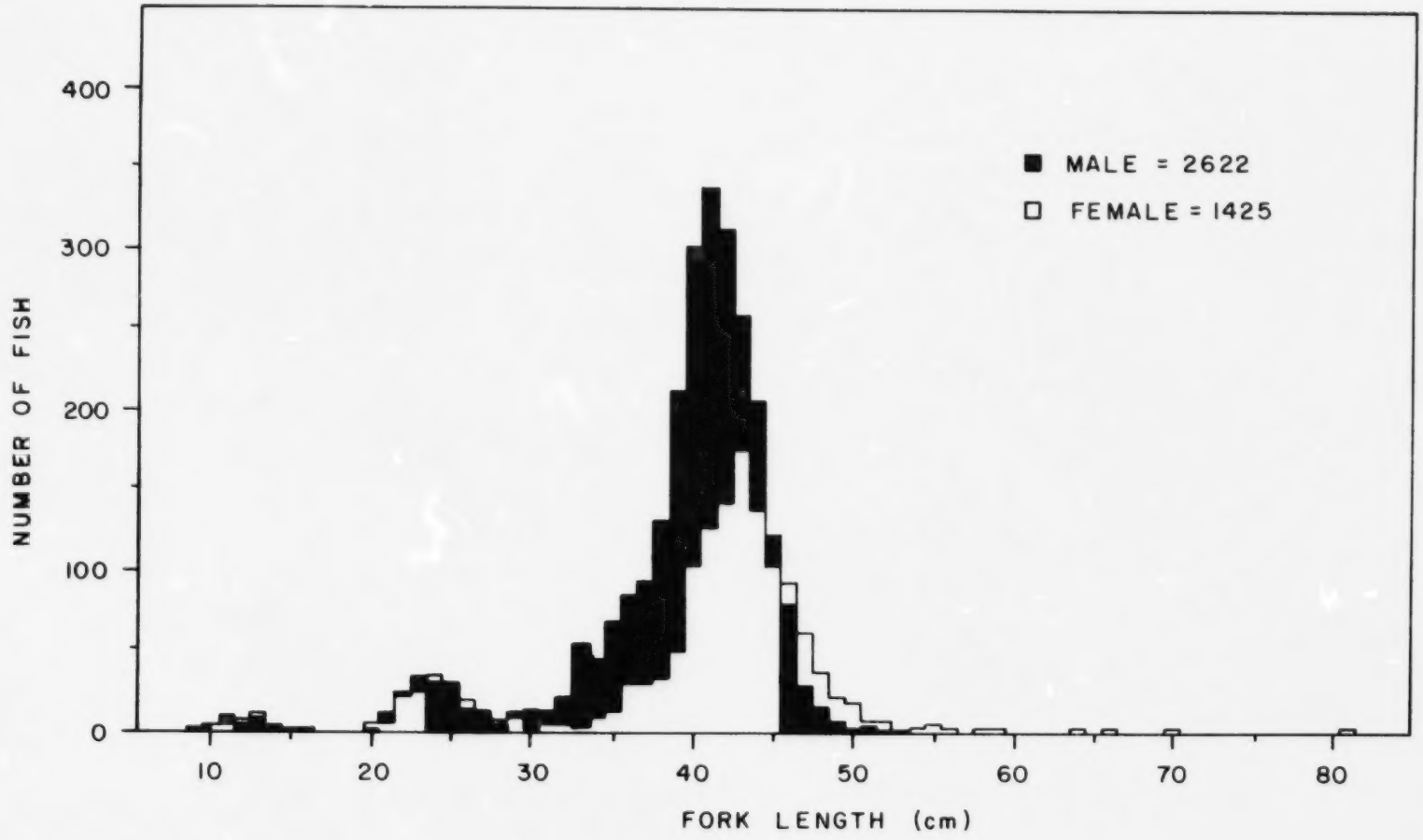

Fig. 5. Pacific hake length frequency by sex. R/V G.B. REED, March 18-29, 1985.

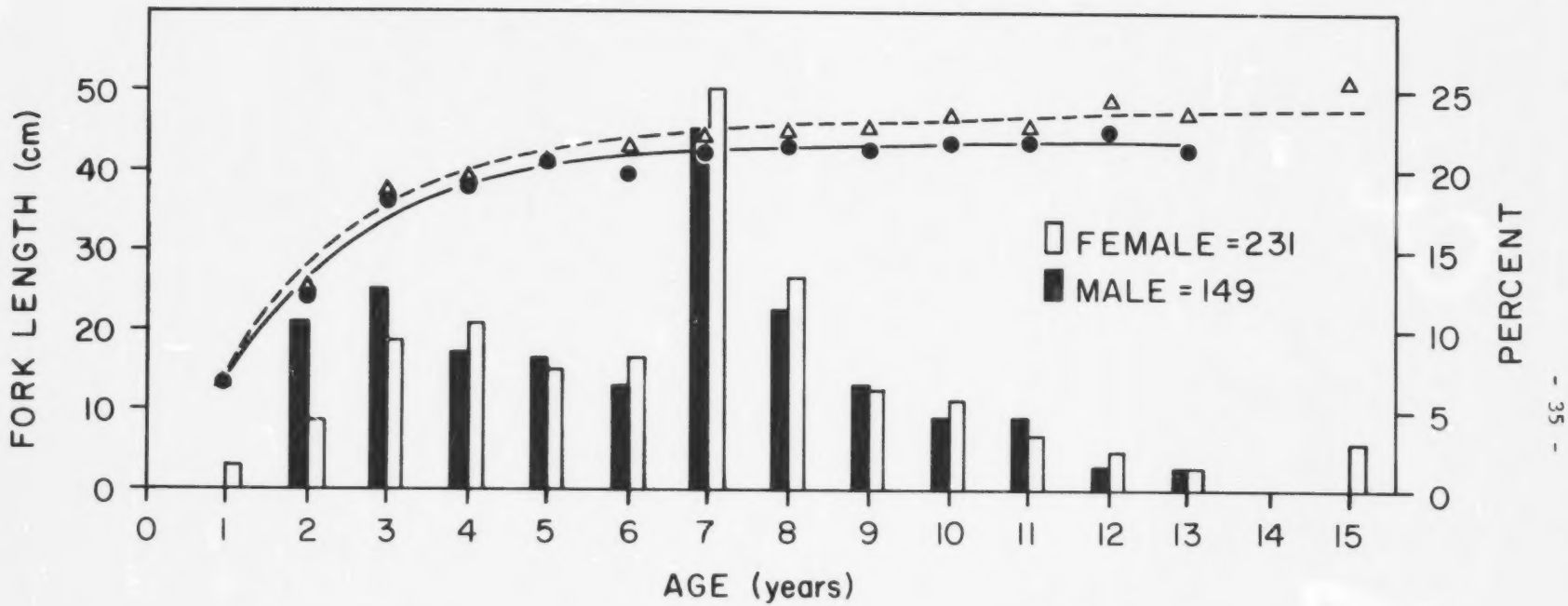

Fig. 6. Pacific hake age frequency and growth curves (fitted by eye) by sex sampled from sets 11 and 16. R/V G.B. REED, March 18-29, 1985.

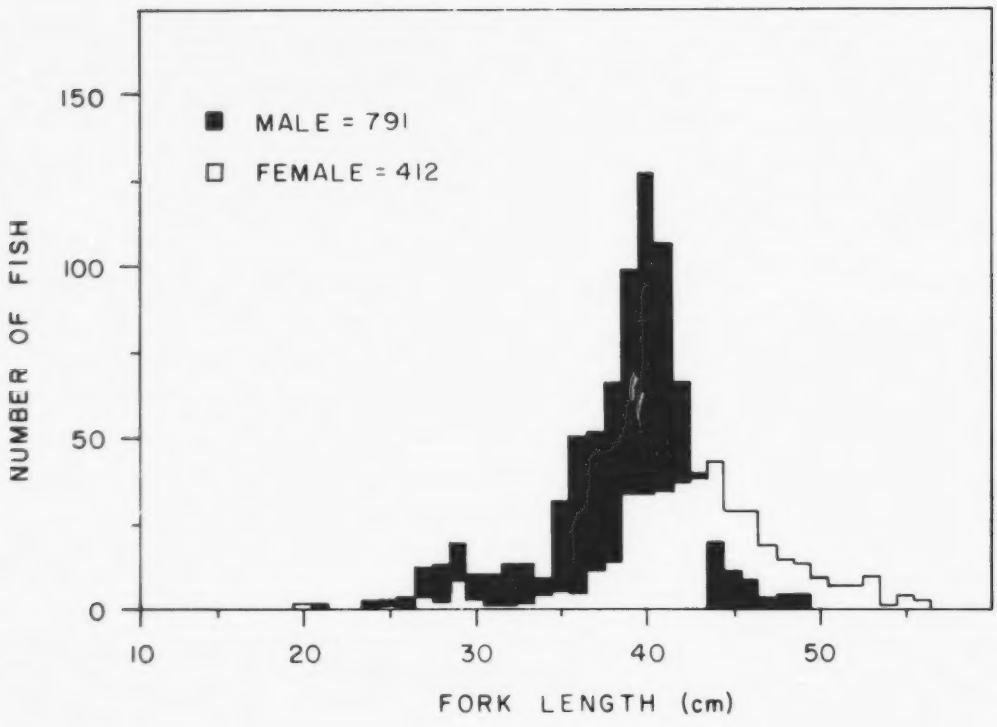

Fig. 7. Walleye pollock length frequency by sex. R/V G.B. REED, March 18-29, 1985.

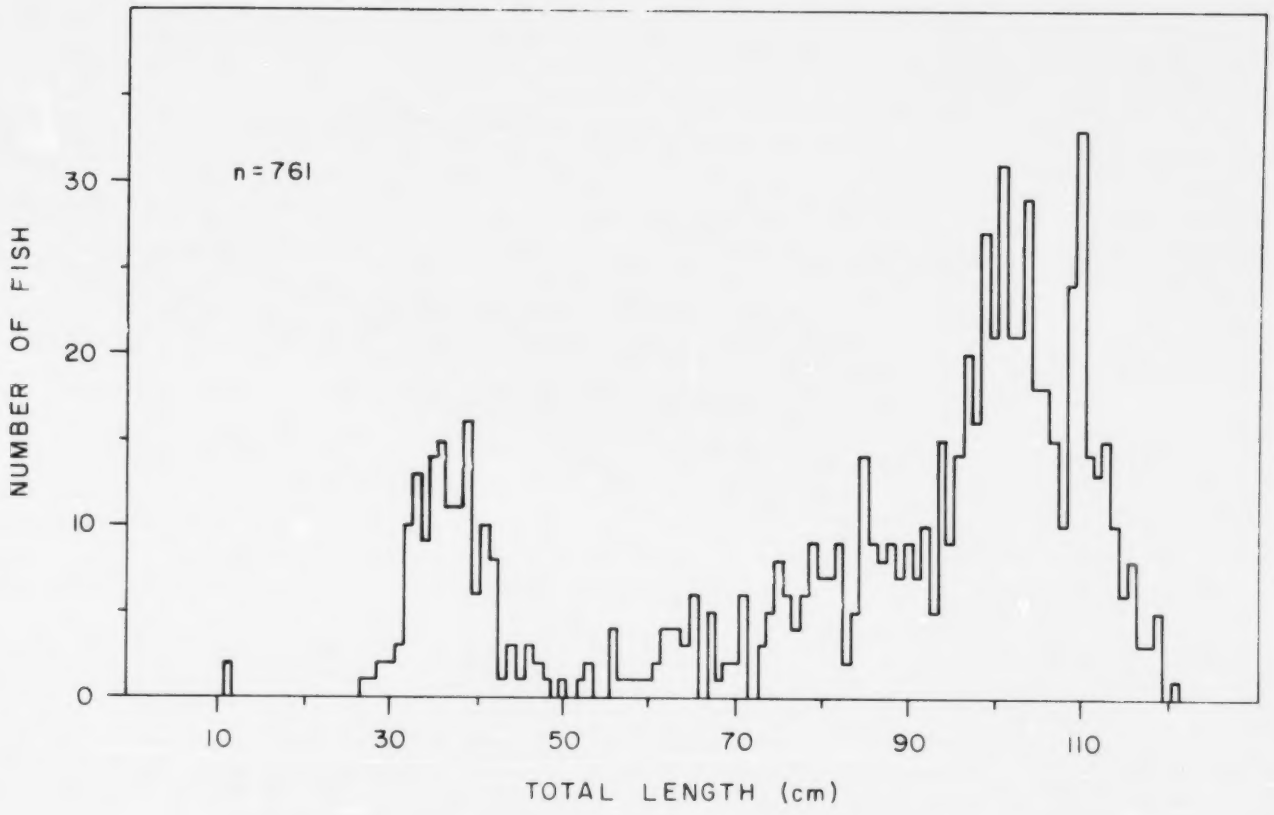

Fig. 8. Spiny dogfish length frequency. R/V G.B. REED, March 18-29, 1985.

Aopendix table 1 through Appendix table 5 do not appear in paper, but appear in microfiche form at the back of this report.